



**National Aeronautics and
Space Administration**

**MSFC-RQMT-2629B
December 12, 2013**

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Huntsville Operations Support Center (HOSC) Telescience Resource Kit (TReK) Requirements Document

**Revision B
December 2013**

Mission Operations Systems Branch

December 12, 2013

Huntsville Operations Support Center (HOSC)
Telescience Resource Kit (TReK)
Requirements Document
(MSFC-RQMT-2629)

Revision B

December 12, 2013

Mission Operations Systems Branch
Mission Operations Laboratory
Engineering Directorate
Marshall Space Flight Center

In support of:
NASA Contract #NNM12AA10C

Approved by

EO01/Jay Onken, Director
Mission Operations Laboratory

EO50/Angela Marsh, Branch Chief
Mission Operations Systems Branch

EO50/Michelle Schneider, Lead
Systems Software Development Team

TABLE OF CONTENTS

<u>PARAGRAPH</u>	<u>PAGE</u>
1 INTRODUCTION.....	1-1
1.1 PURPOSE.....	1-1
1.2 SUPPORTING FACILITIES	1-1
1.3 TREK INTERFACES	1-2
1.4 GOALS	1-2
1.5 APPLICABLE DOCUMENTS.....	1-2
1.6 CONTROL.....	1-2
2 ASSUMPTIONS.....	2-1
3 REQUIREMENTS.....	3-1
3.1 GENERAL	3-1
3.2 TELEMETRY AND OTHER INCOMING DATA.....	3-1
3.3 DATA DISPLAY, COMPUTATIONS, AND SCRIPTING	3-2
3.4 COMMANDING	3-2
3.5 DATABASE	3-3
3.6 UTILITIES	3-4
3.7 APPLICATION PROGRAMMING INTERFACE	3-4
3.8 TREK CHECKOUT	3-5
3.9 SECURITY	3-5
3.10 HOSC PAYLOAD ETHERNET GATEWAY (HPEG).....	3-6
3.11 FILE TRANSFER.....	3-6
3.12 DELAY TOLERANT NETWORK (DTN)	3-6
APPENDIX A ACRONYM LIST.....	1
APPENDIX B GLOSSARY	1

This Page Intentionally Left Blank.

1 INTRODUCTION

The Telescience Resource Kit (TReK) software is one of the Payload Operations Integration Center (POIC) Remote Operations solutions. This option is suitable for Telescience Support Centers, Payload Teams, or Individuals. The Telescience Resource Kit (TReK) is a suite of PC-based software applications that can be used to monitor and control a payload onboard the International Space Station (ISS). TReK provides both local ground support system services and an interface to utilize remote services provided by the POIC. The TReK software may output products that can be used in conjunction with capabilities provided by Commercial Off The Shelf software products. COTS include licensed commercial software, shareware, and freeware. TReK telemetry capabilities include receiving, processing, recording, forwarding, and displaying telemetry data. TReK Command capabilities include sending commands, updating the content of commands, and monitoring/recording/tracking command activities. TReK database capabilities include local database support for both telemetry and command information. Information needed to populate databases can be downloaded from a supporting facility (e.g. POIC) database. TReK capabilities also include an Application Programming Interface (API) that can be used to retrieve telemetry data and perform commanding functions from user developed software programs. In addition, the TReK software can interface directly with a Suitcase Simulator system for flight tools checkout. TReK users are responsible for system configuration, system management, and security.

1.1 PURPOSE

This TReK requirements document has been organized with a specific implementation approach in mind based on the TReK project concept. A key part of the concept defines TReK as a COTS based system. Many requirements will be met by identifying a commercial product and by providing an interface to the product. Complete specifications for COTS products have not been developed. Instead, detailed capabilities provided through Enhanced HOSC System user applications will be used as the guideline for selecting commercial products. For example, a TReK user should assume that the commercial product selected to cover data display requirements will provide functionality similar to that found in the EHS Display Services applications. One should not assume that it will be possible to find a commercial product that provides an identical set of capabilities with regard to EHS applications. However, the goal is to match the functional capabilities as closely as possible. For these reasons, the TReK requirements document contains language such as "The TReK COTS product shall...". The intent is to identify within the TReK requirements document which requirements will be met with a commercial product.

1.2 SUPPORTING FACILITIES

A supporting facility is defined as a facility running EHS software. A supporting facility provides access to telemetry data, copies of telemetry and command databases, and support for commanding activities. Current supporting facilities include the Huntsville

December 12, 2013

Operations Support Center (HOSC) POIC and the Payload Test and Checkout System (PTCS) at Kennedy Space Center (KSC).

1.3 TREK INTERFACES

The POIC to Generic User Interface Definition Document (PGUIDD) (SSP-50305) defines the interfaces between the POIC and the TReK software. Information about interfaces between TReK and the Suitcase Simulator system is defined in the Suitcase Simulator to Telescience Resource Kit Interface Control Document (ICD-3-60079).

1.4 GOALS

There are several goals associated with the TReK project that are difficult to represent as requirements. In order to preserve these ideas, they have been included in this document as goals.

1. The primary goal of the TReK project, is to provide an inexpensive telemetry and command workstation option to remote users. The target goal is to keep the total cost under \$10,000 in FY96 dollars.
2. Where possible, TReK is to utilize commercial products in lieu of developing new software.

1.5 APPLICABLE DOCUMENTS

SSP-50304	POIC Capabilities Document
SSP-50305	POIC to Generic User Interface Definition Document
MSFC-DOC-1949	Marshall Space Flight Center (MSFC) HOSC Telemetry and Command Database Definition Document
MSFC-STD-1274B	MSFC HOSC Telemetry Format Standard
MSFC-STD-2535	MSFC HOSC Command Format Standard
ICD-3-60079	Suitcase Simulator to Telescience Resource Kit Interface Control Document

1.6 CONTROL

This document is controlled by the HOSC Management Coordination Group (HMCG).

2 ASSUMPTIONS

There are several assumptions that have been made about the TReK project and the TReK environment. These assumptions have been included in this document so this information is available to potential TReK users.

1. TReK users will be responsible for purchasing and configuring hardware to host the TReK software.
2. TReK users will be responsible for purchasing, installing, and configuring any recommended commercial software products.
3. TReK users are responsible for system management, system configuration, and system security.
4. TReK users will be responsible for communicating directly with vendors for training associated with commercial products.
5. TReK users will be responsible for communicating directly with vendors about any issues associated with product functionality for commercial products identified for use with TReK.
6. The POIC does not support uplink requests for hazardous commands from remote sites (therefore TReK cannot provide this capability).
7. The TReK Computations capability will not support updating external pseudos stored at a supporting facility.
8. TReK Computations are not compatible with EHS computations software.
9. TReK Scripts will not support updating external pseudos stored at a supporting facility.
10. TReK scripts are not compatible with EHS scripting software.
11. Database files from a Supporting Facility can be used to populate local TReK databases.
12. A TReK user can make modifications to the data in a local TReK databases at the user's own risk.
13. Reconfiguration changes (such as re-loading a database) will not be made automatically. They will require user intervention.
14. TReK users are responsible for ensuring that commands are not sent based on information from playback telemetry data vs. real-time telemetry data. There will be no software constraints placed within TReK flight tools, such as scripts, to prevent a user from evaluating playback data to determine whether or not to uplink a command.

This Page Intentionally Left Blank.

3 REQUIREMENTS

3.1 GENERAL

This section addresses general requirements associated with system software, hardware, and system installation and configuration.

1. TReK shall include installation software.
2. TReK software shall be designed to operate on the following operating systems:
 - a. Windows (e.g. Windows 7, etc.)
 - b. Linux (e.g. Red Hat Enterprise Linux 6, etc.)
3. TReK software shall be designed to operate with a monitor configurable for a resolution of 1024 X 768 pixels.
4. TReK software shall be designed to operate with an ethernet network interface.
5. TReK software shall not impose artificial limits on the data ingest rate.

3.2 TELEMETRY AND OTHER INCOMING DATA

This section addresses TReK telemetry requirements and requirements associated with any incoming data.

1. TReK shall provide the capability to receive and process the following types of data as defined in the PGUIDD (SSP-50305):
 - a. Payload Data System Services (PDSS) Payload Data
 - b. PDSS User Data Summary Message Data
 - c. Ground Support Equipment Data
 - d. Custom Data Packet Data
 - e. Retrieval Processing Summary Message Data

Note: This requirement implies that TReK must support processing associated with the EHS Protocol – data modes, EHS protocol types, etc.

2. TReK shall provide the capability to receive Consultative Committee for Space Data Systems (CCSDS) data from a Suitcase Simulator system as defined in the Suitcase Simulator to Telescience Resource Kit Interface Control Document (ICD-3-60079).
3. TReK shall support data processing as described in MSFC-STD-1274B.
4. TReK shall provide a data conversion capability to convert data to standard data types compatible with TReK applications and hardware.
5. TReK shall provide the following data calibration capabilities:
 - a. Polynomial Calibration
 - b. Point Pair Calibration
 - c. State Code Calibration
6. TReK shall provide a limit/expected state sensing capability.

December 12, 2013

7. TReK shall provide the capability to record incoming data.
8. TReK shall provide the capability to forward incoming data to one or more unicast or multicast Internet Protocol (IP) addresses.
9. TReK shall provide a mechanism to share internal pseudo telemetry values between local TReK applications.
10. TReK shall provide the capability to process playback data from the POIC's Data Storage Manager as defined in the PGUIDD (SSP-50305).
11. TReK shall provide the capability to convert data from files retrieved from the POIC's Data Storage Manager as defined in the PGUIDD (SSP-50305) into an input format that is accepted by TReK.
12. TReK shall provide the capability to record individual telemetry parameters.
13. TReK shall provide the capability to extract individual telemetry parameters from recorded data files.
14. TReK shall provide a "playback" capability for data stored in TReK data recording files.
15. TReK shall provide telemetry statistics information.
16. TReK shall provide the capability to record telemetry statistics information.
17. TReK shall provide the capability to view the contents of a data packet in a text/hexadecimal format.
18. TReK shall provide the capability to view data parameter values via a text display.

3.3 DATA DISPLAY, COMPUTATIONS, AND SCRIPTING

This section covers requirements associated with data display, computations, and scripting. TReK relies on commercial software products to meet needs associated with data display, computations, and scripting. The intent is to identify commercial software products that are capable of producing products (displays, computations, scripts) similar to those used in the POIC. [For more information about POIC requirements in these areas please reference POIC documentation.] The TReK Application Programming Interface capability is used to provide an interface between the TReK software and the commercial software.

1. One or more commercial software products shall be identified to provide a data display capability.
2. One or more commercial software products shall be identified to provide a computation capability.
3. One or more commercial software products shall be identified to provide a scripting capability.

3.4 COMMANDING

This section covers requirements associated with commanding.

1. TReK shall provide the capability to establish a commanding interface with the POIC as defined in the PGUIDD (SSP-50305).

Note: This requirement implies that TReK can process all the command messages defined in the PGUIDD (e.g. command status and configuration messages, command responses, etc.).

2. TReK shall provide the capability to send commands to a Suitcase Simulator system as defined in the Suitcase Simulator to Telescience Resource Kit Interface Control Document (ICD-3-60079).
3. TReK shall provide the capability to track commands.
4. TReK shall provide the capability to record a command session.
5. TReK shall provide the capability to view a command session in a text/hexadecimal format.
6. TReK shall provide command statistics information.
7. TReK shall provide a command management capability.

Note: The intent of this capability is for one TReK system to act as a command gateway for other TReK systems. The TReK system that serves as the command gateway will be responsible for managing command requests from other TReK systems.

3.5 DATABASE

This section covers requirements associated with local TReK databases. TReK relies on a commercial software product for relational database support (referred to in the text below as “TReK Database COTS product”).

1. TReK shall provide a local Telemetry Database capability that meets the following minimum requirements:
 - a. Provide screens to input, edit, and delete database data.
 - b. Host, at a minimum, the following telemetry data:
 1. Identifiers
 2. Descriptions
 3. Formats
 4. Engineering units
 5. Calibration/conversion data
 6. Limits/expected states
 7. Decomposition data
 8. Data Type
 - c. Provide a report capability
 - d. Accept as input bulk downloads from an EHS database that adheres to MSFC-DOC-1949

Note: TReK only supports the POIC’s partial database download capability when retrieving information by APID.

2. TReK shall provide a local Command Database capability that meets the following minimum requirements:
 - a. Provide screens to input, edit, and delete database data.

- b. Host, at a minimum, the following command data:
 - 1. Mnemonics and other identifiers
 - 2. Descriptions
 - 3. Formats
 - 4. Command constraints and restrictions
 - 5. Predefined command data
 - 6. Modifiable command data
 - 7. Decalibration data
 - 8. Header Data
 - 9. Input Data Type
 - 10. Uplink Data Type
 - c. Provide a report capability
 - d. Accept as input bulk downloads from an EHS database that adheres to MSFC-DOC-1949
- 3. The TReK Database COTS product shall provide the capability to extend the local Telemetry Database by providing the ability to modify any of the database data.
 - 4. The TReK Database COTS product shall provide the capability to extend the local Command Database by providing the ability to modify any of the database data.

3.6 UTILITIES

This section covers requirements associated with utilities. TReK relies on commercial software products and the host operating system to meet needs identified in this section.

- 1. A COTS product shall be identified to meet basic word processing capabilities.
- 2. A COTS product shall be identified to meet basic spreadsheet capabilities.
- 3. A COTS product (or the host operating system) shall be identified to provide GMT time display.

3.7 APPLICATION PROGRAMMING INTERFACE

This section covers requirements associated with the TReK Application Programming Interface. The API meets two primary purposes: 1) It provides a bridge between the TReK software and commercial software programs, and 2) it provides a way for a user to extend TReK capabilities. By using the API, a user can move telemetry data from the TReK software into a user developed software program or send a command from a user developed software program to TReK.

- 1. The TReK API shall meet ANSI C requirements.
- 2. The TReK API shall provide the capability to request and receive unprocessed, converted, and calibrated telemetry data samples.
- 3. The TReK API shall provide the capability to request and receive internal pseudo telemetry data stored on the local TReK system.

4. The TReK API shall provide the capability to update internal pseudo telemetry data stored on the local TReK system.
5. The TReK API shall provide the capability to receive EHS status characters for requested telemetry data.
6. The TReK API shall provide the capability to output EHS status characters associated with preprocessed telemetry data.
7. The TReK API shall provide the capability to submit a remotely initiated command uplink request.
8. The TReK API shall provide the capability to submit a remotely generated command uplink request in the following ways:
 - a. TReK generates the complete bit-pattern for the command.
 - b. TReK generates the header portion of the command and the data zone is provided by a user-developed software program,
 - c. A User developed software program generates the complete bit-pattern for the command (header and data zone).
9. The TReK API shall provide the capability to submit modifiable command data to a supporting facility for storage in the supporting facility's database.

3.8 TREK CHECKOUT

TReK Checkout refers to several different types of checkout capabilities provided by a TReK system. This includes Standalone Checkout (training), Flight Tools Checkout, and Interface Testing Checkout. Standalone Checkout provides a way for the user to use TREK software without a supporting facility or network connection. The user can practice using TReK COTS products and can begin building and using TReK flight tools such as displays, computations, and scripts. The Flight Tools Checkout capability provides a way to checkout flight tools using real payload data. TReK will support an interface with a Suitcase Simulator for receiving telemetry (CCSDS packets) and sending commands. This provides a way for an experimenter to checkout flight tools using payload hardware while it is still located in a ground based laboratory. Interface Testing Checkout refers to the capability to use TReK software for an interface test with a supporting facility.

1. TReK shall provide a Standalone Checkout (training) capability.
2. TReK shall support an interface with a Suitcase Simulator to receive CCSDS telemetry packets and submit commands in support of Flight Tools Checkout.
3. TReK shall provide the capability to configure the TReK software in support of Interface Testing Checkout with a supporting facility.

3.9 SECURITY

1. The target operating system to host the TReK software shall provide the capability to require a user name and password to gain access to the system.
2. It shall be possible to configure the system hosting the TReK software to meet AIS Level II.

December 12, 2013

3. TReK shall meet the security interface required between the TReK software and the supporting facility, regardless of the location of the supporting facility that is hosting the EHS software.

3.10 HOSC PAYLOAD ETHERNET GATEWAY (HPEG)

This section covers requirements associated with the HOSC Payload Ethernet Gateway service.

1. TReK shall provide the capability to establish an HPEG interface with the POIC as defined in the PGUIDD (SSP 50305).

3.11 FILE TRANSFER

This section covers requirements associated with file transfer.

1. TReK shall provide the capability to transfer a file using the CCSDS File Delivery Protocol.

3.12 DELAY TOLERANT NETWORK (DTN)

This section covers requirements associated with Delay Tolerant Networking.

1. TReK shall provide the capability to support Bundle Protocol.
2. TReK shall provide the capability to support CCSDS File Delivery Protocol over Bundle Protocol.

DCN
004

APPENDIX A ACRONYM LIST

AIS	Automated Information Security	
API	Application Programming Interface	
BP	Bundle Protocol	DCN 004
CCSDS	Consultative Committee for Space Data Systems	
COTS	Commercial Off The Shelf	DCN 004
DTN	Delay Tolerant Network	
EHS	Enhanced HOSC System	
FPD	Flight Projects Directorate	
GSD	Ground System Department	
HOSC	Huntsville Operations Support Center	
HPEG	Huntsville Operations Support Center (HOSC) Payload Ethernet Gateway	
ICD	Interface Control Document	
ISS	International Space Station	
KSC	Kennedy Space Center	
MSFC	Marshall Space Flight Center	
PDSS	Payload Data Services System	
PGUIDD	POIC to Generic User Interface Definition Document	
POIC	Payload Operations Integration Center	
PTCS	Payload Test Checkout System	
TReK	Telescience Resource Kit	
TSC	Telescience Support Center	

This Page Intentionally Left Blank.

APPENDIX B GLOSSARY

Calibration

Calibration is the transformation of a parameter to a desired scientific dimension (engineering unit) or a text state. Parameters may be calibrated by polynomial equation, point pair (linear segment) interpolation, or by mapping a value to a text state code.

Command

A complete, defined sequence of data which communicates information from a source, either ground based or flight system based, to a payload or spacecraft destination.

Command Attributes

Command attributes refer to static information about a command such as the mnemonic, technical name, whether it is predefined or modifiable, etc.

Command Responses

Command responses are messages that acknowledge the acceptance or non-acceptance of a command. Command responses are dependent upon spacecraft design and ground system command routing.

Command Track

Command Track provides real-time information about the most recent commanding activities. Specifically, command track includes a list of information for each command including the command mnemonic, the time the command was sent, and the command responses associated with the command.

Computation

A software program written in a conventional programming language such as C or C++. A computation is compiled.

Conversion

Conversion is the conversion of downlinked spacecraft data types to ground system platform data types. The MSFC HOSC Telemetry Format Standard, MSFC-STD-1274B identifies supported downlink data types.

COTS Product

COTS stands for Commercial Off The Shelf. In TReK terms COTS products include commercial products, shareware, and freeware.

Decommuration (decom)

Extraction of a measurement or parameter from telemetry.

Enhanced HOSC System

The Enhanced HOSC System refers to the hardware and software systems hosted within the Huntsville Operations Support Center.

Exception Monitor (EM)

Continuous monitoring of one or more measurements for limit/expected state exceptions (violations). Violation notification is provided through a text message.

Expected State Sensing

Expected State Sensing is the detection of a parameter not being in its nominal state. This processing is a corollary of state code calibration where a parameter is mapped to a

December 12, 2013

text state code. One of the state codes must be selected as the "expected state". Processing detects violation of this "expected state".

Flight Tools

See TReK Flight Tool

Hazardous Command

A command whose initiation and execution could pose a threat to human life or entire mission.

Huntsville Operations Support Center (HOSC)

The Huntsville Operations Support Center (HOSC) is a NASA ground control center located at Marshall Space Flight Center in Huntsville Alabama. The HOSC mission is to provide real-time and near real-time telemetry processing, command processing, and mission planning in support of pre-launch integration and checkout, simulation, training, and flight operations.

Limit Sensing

Limit Sensing is the detection of caution and warning conditions for a parameter. A separate high and low range may be defined for caution and warning conditions respectively.

Modifiable Command

Command whose values can be updated in real-time (e.g., setting a temperature)

Packet

Asynchronous data wrapped in a packet protocol. Consultative Committee on Space Data Systems (CCSDS) packets can be used for downlink telemetry by the spacecraft. The EHS encapsulates all telemetry data in a HOSC packet protocol layered on top of CCSDS for internal routing.

Pseudo Telemetry (or pseudos)

Value that has been computed from downlinked telemetry or other computed parameters.

Script

A script is a software program that contains a set of English-like instructions called directives. A script is interpreted not compiled. The term "automated procedure" is often used interchangeably with the term "script".

Status Characters

Status characters are used to provide information about the status of a telemetry or pseudo telemetry data value. Status characters are one character long and can represent a variety of information about the data value including data not available (N), static data (S), undefined MSID (U), etc.

Supporting Facility

A supporting facility is defined as a facility running EHS software. A supporting facility provides access to telemetry data, copies of telemetry and command databases, and support for numerous commanding activities.

TReK Flight Tool

Displays, Computations, and Scripts are considered TReK flight tools. The term "flight tool" is used to refer to a software entity developed by the user (such as a display), using one or more TReK software products.

This Page Intentionally Left Blank.